The role of apex predators in coastal ecosystems: a case study examining the Broadnose sevengill shark *Notorynchus cepedianus*

by

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DECLARATIONS

Statement of Originality

This thesis contains no material that has been accepted for a degree or diploma by the University or any other institution. To the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due acknowledgement is madein the text.

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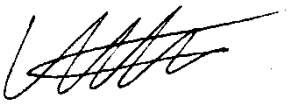
Statement of Ethical Conduct

All research was conducted with approval from the University of Tasmania Animal Ethics Committee (#A0009120) and the Department of Primary Industries and Water (Permit #8028).



Adam Barnett

Date:_October 2011

Statement of Co-authorship

Chapters 2- 5 and 7 of this thesis have been prepared as scientific manuscripts as identified on the title page for each chapter. In all cases experimental design, field and laboratory work, data analysis and interpretation, and manuscript preparation were the primary responsibility of the candidate. However, they were carried out in consultation with supervisors and in some chapter's collaboration with co-authors. Contributions and Institutional affiliation of the co-authors at the time of the studies are outlined below:

Chapter 2

Jayson Semmens (Institute for Marine and Antarctic Studies - IMAS) and John Stevens (CSIRO) are the primary supervisors for this PhD. Both provided advice on field techniques and manuscript preparation and participated in field work. John Stevens instructed A. Barnett on best practices for catching and handling sharks. Stewart Frusher (IMAS) commented on the manuscript.

Chapter 3

Kevin Redd (IMAS PhD student) provided technical and operating expertise to the DNA analysis. He also assisted in writing the methods section of the manuscript and commented on the overall manuscript. Jayson Semmens proposed the original concept of using DNA analysis and provided advice to manuscript preparation. John Stevens provided advice to manuscript preparation and field work. Stewart Frusher commented on the manuscript.

Chapter 4

Jayson Semmens and John Stevens provided advice to manuscript preparation. Jonah Yick (IMAS honours student) assisted in field work and laboratory analysis of stomach contents. He also had input on data analysis. Kátya Abrantes (IMAS Research Fellow) assisted in field work and advice on manuscript preparation as well as providing advice and assistance in data analysis. Stewart Frusher commented on manuscript.

Chapter 5

Jayson Semmens provided advice on experimental design, the surgical methods used to implant acoustic tags in the sharks and manuscript preparation. John Stevens provided help with collating and dealing with PAT tag data and commented on manuscript. Kátya Abrantes commented on manuscript, assisted with field work and gave statistical advice on data analysis.

Chapter 6

Currently in review, Jayson Semmens assisted with field work and commented on manuscript.

Chapter 7

Jayson Semmens provided the expertise on setting up and maintaining the VRAP. He also contributed to surgically implanting the tags in the sharks and manuscript preparation. John Stevens and Barry Bruce (CSIRO) commented on the manuscript and participated in the active tracking field work, as well as supplying equipment and advice. Kátya Abrantes contributed to field work, manuscript preparation and data analysis.

Signed:  _____

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ABSTRACT

Large apex predators are believed to play key roles in ecosystem structure and dynamics. However, for the vast majority of large predators their ecological roles have not been defined or quantified. In particular, there is a lack of information on large mobile marine species. The ecology of the Broadnose sevengill shark*, Notorynchus cepedianus* was examined to determine their role in coastal systems of Tasmania. This was addressed by conducting studies on the different aspects of *N. cepedianus* ecology in two coastal areas of south-east Tasmania; the Derwent Estuary and Norfolk Bay. Both these areas are designated shark protected areas. Seasonal longline sampling showed that adult and sub-adult *N. cepedianus* (size 105-295cm) are highly abundant in summer declining to near absence in winter. The absence of smaller size classes (<80cm) from the catches suggests that *N. cepedianus* are not using these coastal habitats as nursery areas. Both longline sampling and acoustic movement analysis demonstrated that *N. cepedianus* showed site fidelity in the use of the coastal habitats. The general pattern was for sharks to exit coastal areas over winter and return the following spring or summer. However, sexual segregation was evident with females abundant in spring and to a lesser extent occurring in winter; conversely males appear in coastal areas later in summer. Both satellite and acoustic tracking methods showed that males can make northerly migrations during winter to distances of at least 1000km. Individuals tagged in both coastal areas (Derwent Estuary and Norfolk Bay) showed low spatial (Pianka's index: O = 0.34) and dietary overlap (O = 0.45), suggesting localised site fidelity and fine spatial scale resource partitioning. In general, individuals from both locations consumed the same broad dietary categories (sharks, batoids, teleosts and mammals). However, there were differences in species composition within these categories for each location. The simultaneous tracking of five chondrichthyan prey species and *N. cepedianus* showed similar seasonal use of coastal areas by all species. Predator and prey also showed high spatial overlap and similar habitat use patterns once they were within the coastal system. These similar movement patterns of predator and prey combined with the additional ecological information (diet, relative abundance) suggests that *N. cepedianus* display feeding site fidelity, moving into coastal systems following their main chondrichthyan prey. These combined approaches demonstrate that *N. cepedianus* probably exert significant predation pressure on prey using these protected coastal areas during summer. Natural mortality is an important, but difficult parameter to estimate in assessing commercially fished populations. However, given the common occurrence and high abundance of *Notorynchus cepedianus* in the Tasmanian coastal waters gazetted as shark nursery areas and the prevalence of gummy shark *Mustelus antarcticus* in their diet, it is likely that *N. cepedianus* exert significant predation pressure on this commercially important species. Therefore, *Notorynchus cepedianus* is competing with humans (fisheries) as the

top predators for common food resources, and as mortality from predation can exceed that from fisheries, this information is important for fisheries management. Overall this study is an important contribution to the ecology of *N. cepedianus* and marine apex predators in general, but it also illustrates the value of simultaneously recording and integrating multiple types of information to better understand predator-prey relationships, the likelihood of interactions, and to build a clearer picture of ecosystem dynamics.

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